CONFIDENTIAL

File RD-107 To-10
D.R.

Eighth Bimonthly Report on

The RT-21 Transmitter Program

Period 8-Nov.-1959 to 8-Jan.-1960

[redacted] 25X1

Prepared by: [redacted] 25X1

[redacted] 25X1

CONFIDENTIAL

TABLE OF CONTENTS

I. Purpose

See Bimonthly Report No. 1.

II. Abstract

This report describes recent work associated with a speeding up of the operation of the automatic impedance matching unit. In order to obtain satisfactory operation with shorter tune up times, it has been necessary to modify the variable capacitor. Entirely satisfactory operation at higher speeds has not yet been achieved. A preliminary attempt to couple the transmitter to the matching network showed that the output waveform was too distorted for successful operation of the servo system. In the interests of obtaining the maximum power output, the transistors were operated in Class C giving 2.5 watts over the 3-30 mc band. However until the pi network is correctly adjusted the waveform is not good enough for the sensors to know which way to adjust the network.

During a recent meeting with the customer the question of external function controls was discussed. Considerable thought has been given to this problem and the approach presently visualized is described in this report. Almost any degree of simplification from the operator's standpoint as well as any degree of "fool proofing" can be incorporated by means of additional circuitry. The compromise which has to be made arises from considerations of reliability, serviceability and overall physical size.

III. Factual Data

(a) Automatic Impedance Matching

During the past reporting period stable operation of the automatic impedance matching unit has been achieved at all points checked within the 3-30 mc band. These check points consist of a variety of both resistive and complex load impedances at the extremes of the two frequency bands, namely, 3 and 15 mc in the low band and 15 and 30 mc in the high band. The stability was achieved by the use of DC compensating networks and non-linear diode compensation.

It was pointed out to the customer in his last visit that the time required for tuning the impedance matching unit could be (depending on load impedance, frequency, and initial component positions) as long as 2 1/2 minutes. However, due to the prepositioning of components, the actual "on the air" time during tune up can be limited to about one-half this amount. Subsequently, an effort has been made to reduce the time required for tuning the automatic impedance matching unit. The speed reduction of the coil was changed from 300:1 to 100:1, and the speed reduction of the capacitor was changed from 3000:1 to 300:1. If successful, this would reduce the maximum tuning time to about 50 seconds. Again, only about one-half this amount need be "on the air" time. However, considerable difficulty has been encountered in trying to make this modification. The chief difficulty appears to be instability of the capacitor servo in the upper regions of the two frequency bands. It appears that some of this difficulty is due to mechanical problems in the operation of the capacitor. At the higher frequencies the capacitive

susceptance changes rapidly with relatively small shaft rotations. It is then necessary that the capacitance vary extremely smoothly as a function of angular shaft position. However, in a capacitor where spacing has been held to a minimum in an effort to minimize volume, the mechanical friction between plates results in a capacitance which is not only a slightly discontinuous function of angular position, but is actually multi-valued. The multi-valued characteristic can be attributed to the shifting of the polyethylene insulators between plates as the plates are rotated. In an effort to reduce the effect of these mechanical difficulties, the capacitor is being rebuilt using teflon insulating spacers instead of polyethylene spacers. Teflon is a much better self-lubricant than polyethylene and thus will result in less friction between adjacent surfaces. The polyethylene spacers were used originally because these could be obtained from commercially available capacitors. It has been necessary to use a special template in order to machine the teflon spacers in the Laboratory Model Shop. Less friction is also necessary from a servo sensitivity viewpoint. Increasing the speed of the components reduces the amount of torque available for positioning them (because the torque available from the motors remains constant). Further evaluation of the "faster tuning" servo system has been postponed until the capacitor has been rebuilt.

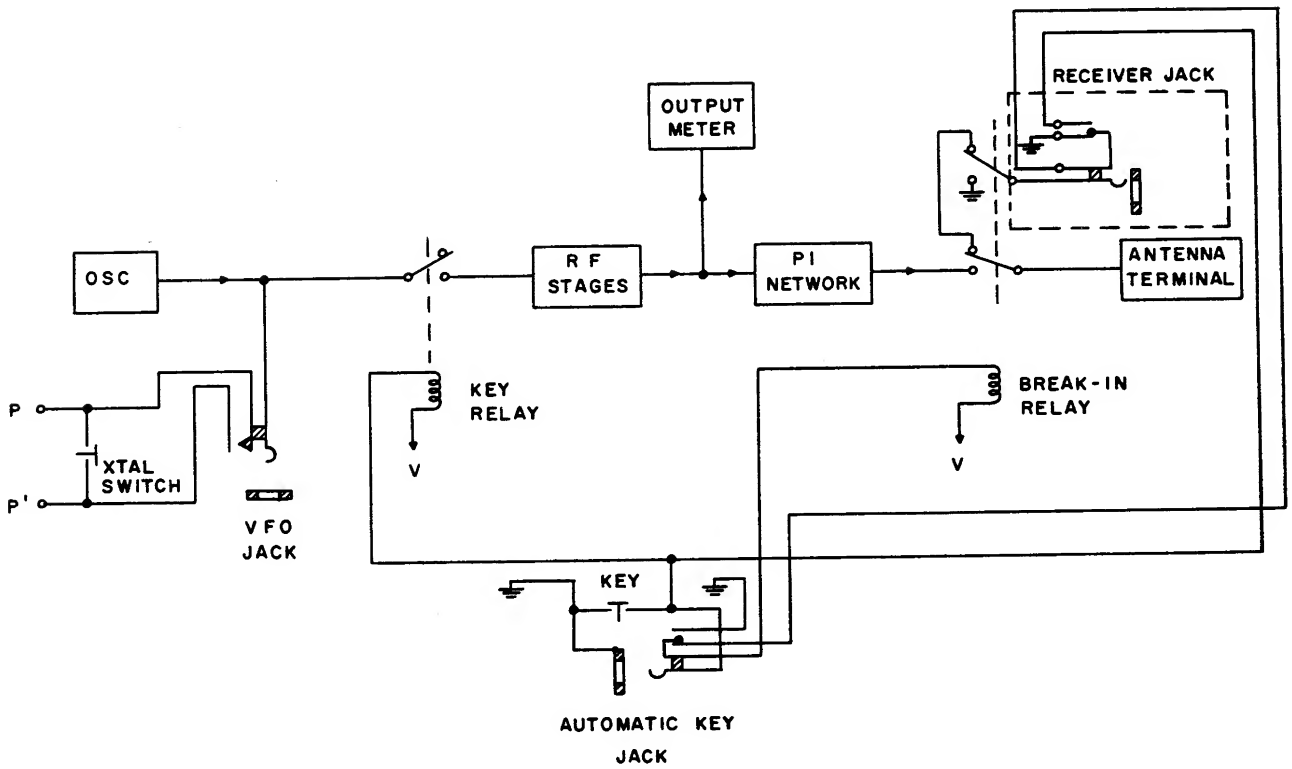
Before the capacitor rebuilding began, the automatic impedance matching unit was briefly tested in conjunction with the transistor RF circuitry. The result of this test indicated that the harmonic content of the RF signal was too great to allow proper operation of the admittance sensing circuitry. Further work is being devoted to the development of sufficiently linear RF circuitry.

(b) Transmitter External Function Circuitry

The paragraphs below give a brief description of the manner in which the following functions may be performed: (1) Turning the transmitter on and off, (2) Receiver connection for break-in operation and (3) Monitoring the transmitter loading.

The transmitter is turned on by either inserting a crystal into the oscillator circuit or connecting a VFO to the RF circuitry. This action operates switches associated with the insertion of these elements. This situation is indicated in Figure 1 where continuity between p-p will result in the application of power to the transmitter. The transmitter is turned off by removing the crystal or the VFO.

It has been stipulated by the customer that a provision shall be made for connecting the antenna to a receiver when the key is in the "up" position. Unnecessary wear of the relay contacts is eliminated if, in the key up position, the antenna is switched to the receiver jack only if a receiver is actually being used. This function is performed by the contacts associated with the receiver jack. Thus, when no receiver is used, the antenna remains connected to the transmitter output. If a receiver is connected, the antenna is switched to the receiver jack when the key is in the "up" position and is reconnected to the transmitter output when the key is in the "down" position. Insertion of the plug from the automatic keyer into the jack maintains the connection of the antenna to the transmitter output regardless of whether or not a receiver is connected.



BLOCK DIAGRAM OF TRANSMITTER EXTERNAL FUNCTION CIRCUITRY

FIGURE 1

The transmitter loading will be monitored by connecting a peak voltage detector at the input of the pi network. This voltage will then be indicated by a miniature microammeter. Since the impedance level at the input of the tuned pi is independent of the terminating impedance, the meter will give an indication of the power delivered to the pi.

IV. Conclusions

A stable impedance matching system has been operated over the 3-30 mc range. A maximum total time for adjustment (including prepositioning) of about 2.5 minutes is required. Efforts have been made to reduce this time to about 50 seconds. Operating at the higher speed some instability has been observed at the high frequency end of each band. Efforts are being made to overcome this trouble.

Coupling the transmitter proper to the matching network has shown that the output waveform is too distorted to permit correct operation of the matching network. This is due to the Class C operation which was used in the output stages in order to obtain as high an output power as possible. In order to reduce the harmonic distortion to a point where the sensors will be able to operate satisfactorily there may be a substantial reduction in power output as a result of operating the output stage in Class A, as called for in the specifications. Due to the limitations of present devices, it was considered worthwhile to operate Class C in order to obtain maximum output power. Although the harmonic content would not be unduly high once the matching network had adjusted itself, it is too high before adjustment has taken place to permit operation of the servo system.

The operation of the transmitter can be made extremely simple. The scheme described here appears to place very little responsibility for successful operation on the operator. The responsibility is, correspondingly, transferred to the electrical circuitry--in particular--relay contacts. In some modes of operation not all the relay functions are required. Efforts have been made in these cases to eliminate the operation of the appropriate relays, in order to conserve the contact life.

V. Future Plans

The first priority is being placed on establishing an output stage design which will provide maximum output power with a sufficiently good waveform that the matching sensors are able to determine the direction in which to proceed initially. As the adjustment is made, of course, the waveform will be improved so that, initially, perfect sine waves are not necessary.

A satisfactory compromise between stability and adjustment time is being sought for the matching network. Backlash appears to be the most significant factor affecting servo stability. Efforts will be made to obtain the shortest adjustment time compatible with system stability.

Due to the necessity for modification of the output stage, work on the power supplies has been delayed. In the interests of small size, it is undesirable to build a power supply which is larger than necessary. The design of the power supply is consequently related to the output power and the efficiency of the output stage.

VI. Key Technical Personnel

See previous reports.